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ABSTRACT

This teacher module provides background information and resources to the Annual Duracell/National Science Teachers Association Scholarship Competition Invention Challenge for high school students. Contents include: (1) "Introduction to the Competition"; (2) "Tips for Motivating Students"; (3) "Preparing for Inventing"; (4) "Teaching Invention: Open-ended Problem Solving, Preparing Students for the Duracell Competition, and Using the Duracell Competition to Supplement Your Curriculum"; (5) "Resources for Students and Teachers"; and (6) "'Scavenger' Parts List and Sample Activities." (CCM)

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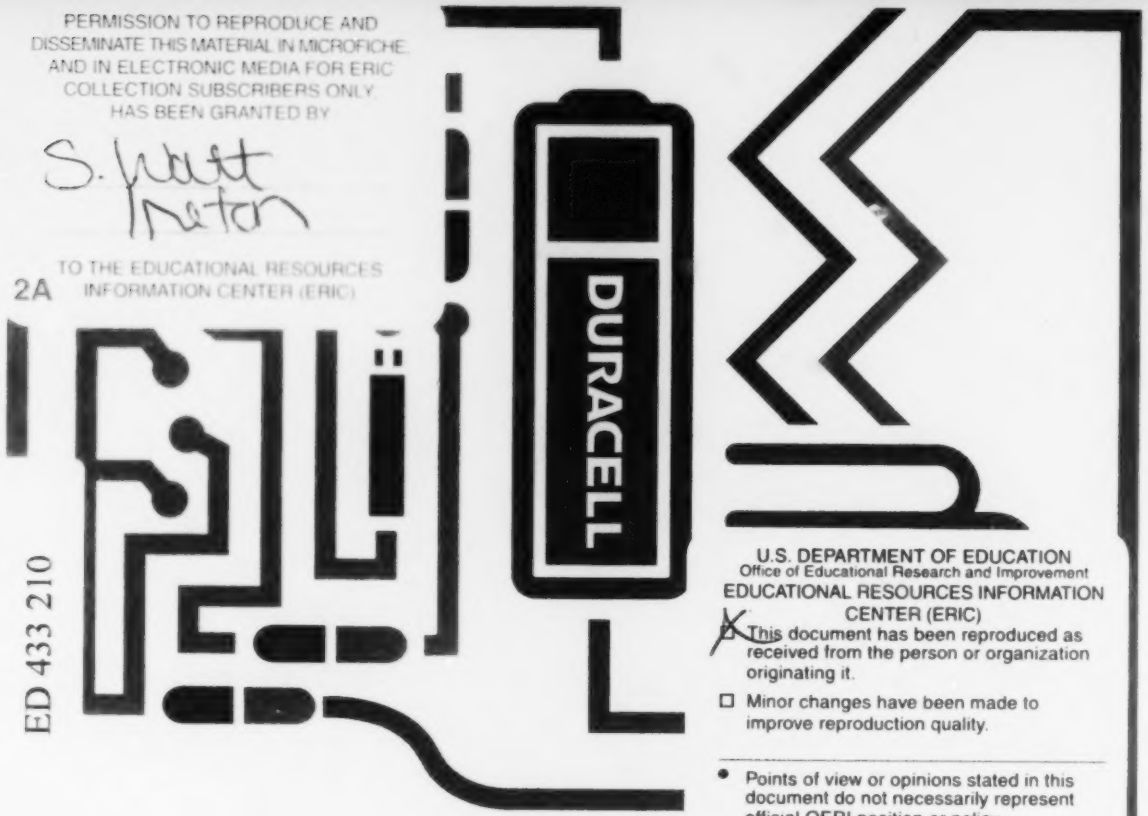

DURACELL/NSTA INVENTION CHALLENGE

Teacher Module

SCIENCE

DURACELL/NSTA
INVENTION CHALLENGE

Teacher Module

Entry Deadline

Mid-January Each Year

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INTRODUCING THE DURACELL/NSTA INVENTION CHALLENGE

Why should students participate?

The Duracell/NSTA contest motivates students to develop critical thinking skills, learn how to solve real life problems and to work cooperatively.

Students can win prizes and have the experience of competing in a national competition.

Creating inventions together has proven to be an effective way to steer students toward learning and to bridge communication gaps.

How should I sell the idea of competing in the contest to my students?

Display the competition poster and brochure in your classroom.

Preview the video, and discuss the benefits of the competition with your class before showing the video.

COMPETITION BENEFITS FOR STUDENTS

Financial Rewards • Resume Enhancement
Scholarships • Savings Bonds for Education
Travel Opportunities • Patent/Sales Opportunities

Point out to the students that most of the winning inventions are not that complex; rather they creatively solve a problem.

Hand out the contest instructions after you have shown the video.

PROBLEMS = SOLUTIONS = INVENTIONS

Tips for Motivating Students

Remember that an idea is a fragile thing. Turning it off is much easier than keeping it lit. Ten ways to squash ideas:

- "You want to do what?"
- "Well, I think it's a little too.."
- "I really like it, but..."
- "Let me play the devil's advocate. . ."
- "I just don't know. . ."
- "You should think about it after you've taken a class in..."
- "Maybe we can talk about it later. . ."
- "I'm not sure that this is what we're looking for."
- "It's a great idea, but it doesn't fit into the curriculum."
- "ha, ha, hoho, hee-hee...."

Look for merit in students' ideas and build on them.

Every invention is a solution to a problem. Tell the students not to think of an invention to make, but to look for a problem they can solve. To help your students appreciate this point, ask them to identify a single man-made object which did not solve a problem. Asked this question, one student in Grant Luton's class made a paper wad and asked what it solved. "I asked the student if he could throw the paper wad into the trash can, and he did," said Luton. "I then asked him to throw a sheet of paper into the trash can without wadding it up. He couldn't. Therefore, wadding up the paper solved the problem of getting the paper into the trash can without having to leave the chair."

Keep it Simple. An invention does not have to be complex to be a winner. Examples of past Duracell winners include a student who fitted a toy semi-truck with a mercury switch and lights to make a model of a tractor trailer tilt warning device. If a truck driver were to turn too quickly, a light on the dash would blink to warn him or her that the vehicle was in danger of tipping over. Another student added a mercury switch assembly to a putter to indicate when a golfer bent his or her wrist, a no-no for proper putting form.

Innovation is also an option. If a student is truly in a bind, an invention is going to be tougher than root canal. Introduce the concept of innovation—taking an existing idea and improving upon it. Innovations are doable and can help a less confident student become a successful inventor.

Ask, "How can I use that?". Whenever they come across an interesting object, part of a toy or machine, or scrap, have your students ask themselves how it might be used to solve a problem.

Make them famous. Maintain a "Wall of Fame" display in a prominent place in your room to record student achievements year by year. Invite the local paper to write about your students too!

Smart and Smarter. Invention contests aren't just for high achievers some of the best inventions in history have come from people who did not excel at school. Remind students of this fact, and display these quotes in your classroom.

ALBERT EINSTEIN: "He should be put into a slow class"
ISAAC NEWTON: "A very poor student"
THOMAS EDISON: "He is too stupid to learn anything"
BEETHOVEN: "As a writer he is hopeless"
WALT DISNEY: "No good ideas"
LOUIS PASTEUR: "Very mediocre in chemistry"

Dress for Success. Make your school classroom imitate real life as much as possible. Provide the students with lab coats to wear during lab sessions. Providing students with both the symbolic and the real aspects of problem solving brings the outside world into the classroom, often with positive results.

Coaching counts. Most athletes do not become stars without training, and training is the result of good coaching. Give your students the nudge they need—they will thank you later.

A Video a Day. Early in the year, set aside one day a week to show a video that will help your students appreciate the invention process, and/or motivate them to dare to invent. The Connections series is an example of good video resource.

It's Not Over Even When It's Over. The benefits of the Duracell contest do not necessarily end at the awards ceremony. Some entries do become products, earning royalties and fame for the inventor. If you have a FREY scientific catalog, take a look at the Storm Globe on page 5. It was a Duracell winner.

As a Duracell winner, a student's invention is also eligible for induction into the National Gallery for America's Young Inventors, located in Inventure Place, home of the National Inventors Hall of Fame in Akron, OH. Each year, six winners (K-12) of national invention contests are inducted into the National Gallery at a gala black tie ceremony. Teachers interested in nominating a student for induction into the National Gallery for America's Young Inventors should write to: Partnership for America's Future, Inc., 80 West Bowery St., Suite 305, Akron OH 44308.

Preparation for Inventing

ORGANIZATION AND RECORDS

Develop a 3"x5" card box for each class. Have each student fill out a "I Did it First" form the moment he or she comes up with an idea for an invention (see below), and file it in the box. The importance of keeping accurate records of when students come up with an idea cannot be over stressed. This record will enable you to settle any disputes among students as to who first thought of an idea, and you can use the cards to record students' progress.

I DID IT FIRST!!!

NAME: _____

PERIOD: _____

DATE/TIME:

IDEA DESCRIPTION:

PLEASE SEE ME:

1ST NOTICE:

Require the students to draw as well as describe their ideas and projects in their journals. You should check these journals, as well as the "I Did It First" files, periodically to stay on top of students' progress and give them a push when needed.

Working Environment and Tools

Provide a working environment conducive to building, hammering, sawing and soldering. Provide the means to store student projects in progress (box lids from photocopier paper are ideal). Also, maintain several tackle boxes of spare parts (electrical hardware, fasteners, tools, etc.) that could potentially be useful. Ask students to bring in unwanted toys and gizmos (working or broken), as these can often be used. The "scavenger" list on page 14 provides examples of other commonly available useful items.

Keep a telephone directory in your room, if possible, and encourage students to call experts for advice or information when it is required. Professionals are nearly always willing to help. Good places to start include the engineering departments of local universities, engineering firms (ask to speak to their public relations officer). Also, keep a copy of the book, "Electronics for Beginners" in your room. Available from Radio Shack for $2.50, it is an invaluable resource for teachers without much background in electronics.

TEACHING INVENTION

"PLEEEEEEEASE drop the T !!!!!"

This is the answer that I usually give to my students whenever they say "I can't," says teacher Javier Rabelo. "Since I get a weird look in response, I follow up by explaining that even if they think that they cannot accomplish something, I CAN always comes before I CAN'T. So drop the T!" Students have to believe that they can solve problems before they can invent.

Before a student can invent something, he/she must be able to solve problems —that is, he/she must be able to analyze a problem, break it into smaller pieces, and solve those. To accomplish that, the student also must be able "organize" his or her approach to finding solutions. Thus, the best way to teach students to be inventors is first to teach them how to solve problems. Once students understand how to approach a task, the teacher becomes the facilitator rather than the leader in the invention process.

OPEN-ENDED PROBLEM-SOLVING

OPEN-ENDED PROBLEM SOLVING

1. Analysis and Investigation (Identify the Problem)
2. Design Brief Development (Defining Objectives)
3. Information Gathering
4. Generation of Multiple Solutions (Brainstorming)
5. Selection of the Best Solution
6. Goal Development (Planning an implementation strategy)
7. Prototype (Implementing a Physical Working Model)
8. Test and Evaluation
9. Redesign/Reimplementation
10. Project Completion

Open-ended problem solving enables students to generate multiple answers to a given problem. This model of problem solving is common to the engineering design process, as well as to many other creative processes. To introduce this approach in your class, start by stating a problem, presenting it to the class in the form of an open-ended design brief. This short introduction sets forth the goals and objectives for the problem and certain limitations and constraints. The following is an example:

> You have been hired by a secret branch of the Government. The agency wants you to design a prototype glider to be used in stealth covert operations. Your assignment is to design a prototype out of one sheet of paper which is capable of gliding 30 feet and which can sustain a hang time of at least three seconds.

This problem allows students to go through every aspect of the problem solving model. Most students already know how to create a paper airplane. They now face limitations and constraints. If limitations are given from a materials list, students tend to stay focused, which is good for both originality and time management.

As the students solve the problem, require them to draft documentation for their invention, including both drawings and text. Include these, along with the actual airplanes, in your evaluation. Technical documentation enables the student to summarize their experience and the graphics enables them to identify the various components or critical parts. Award originality with extra credit.

Preparing Students for the Duracell Competition

A more detailed design project will help your students prepare for the Duracell competition, and help you evaluate your students' problem-solving skills. An exercise, called "Marble Madness", is an example. It allows students to apply concepts such as leverage, pressure, suspension, gravity, force and rotation, thereby reinforcing their understanding for future invention efforts. The design brief for this project, created by teacher Bill Timme, follows:

Marble Madness Design Brief

You have been hired by a major marble manufacturer to construct and invent a marble packaging system. Design and construct a device which will elevate marbles and drop them into a cup, one at a time, by pushing with one finger. Everything must be secured to a base. Only one finger can be used to make your invention load the marbles.

Limitations

Push to lift, no projectiles. Must be safe, simple to construct and easy to operate
Use few materials as possible, and only those on the list

Materials

3 marbles
2 popsicle sticks
1 small piece of aluminum foil
1 small balloon
1 piece of paper
1 rubber band
1 piece of cardboard
1 piece of tape
3 paper cups
1 plastic cup
scissors

Once a prototype is created and it works, require students to create an electrical version. The task of converting mechanical motion into electrical motion is a great introduction to the Duracell Competition. Note that going from a design brief, to an idea, to a prototype, to an electrical solution to the Marble Madness problem may take up to four weeks, even assuming students also work at home.

Using the Duracell Competition as a Supplement To Your Curriculum

The DuracelUNSTA Competition can be a major supplement to any technology course curriculum, as it acts to focus student projects and drive deadlines. By making the competition part of your class work (even as extra credit), you may be able to encourage students who might not otherwise enter a contest. Even if they do not win, the students will gain experience in creatively solving problems.

Inventing an entry for the Duracell competition can take as much as seven or more weeks. Even if you cannot spend that much time on it, consider devoting some class time to help students structure their approach to inventing a Duracell entry by teaching the open-ended problem solving model. Your efforts will encourage your students to work at home, applying the concepts learned in your class. Encouraging independent effort on the students' part also fosters communication with parents, siblings, and friends, since all provide advice and input.

Using the open-ended problem solving model as a rough guide, the schedule to complete a Duracell competition entry is as follows:

Analysis and Investigation	3 days
Framing a Design Brief (Problem)	1 days
Information Gathering (Sub-problems)	3 days
Generate Multiple Solutions	1 week
Choose the Best Solution	3 days
Developmental goal	1 week
Prototyping	2 weeks
Test and Evaluate	1-2 weeks
Redesign/Reimplement	3 weeks
	7-8 weeks

If you decide to incorporate the contest directly into your curriculum, give your students time to work in class, and issue weekly progress grades as well as homework. Have your students submit their technical documentation and drawings for evaluation. This documentation can then become their essay for the competition. You can evaluate this written work using the criteria indicated on the contest application form. The students' sketches become their wiring diagrams. If you cannot devote eight weeks of class time to the contest, consider using this documentation as a basis for awarding extra credit.

One week prior to the competition deadline, take photographs of every student invention that is working, and sign the entry forms. (Wait to sign off on any that

are not quite ready). Two days before the deadline, collect their work (including a typed entry form). Teacher Javier Rabelo recommends that you mail the entry forms via next day mail yourself—having students mail their own forms can lead to entries that do not work, or to late submittal.

RESOURCES FOR TEACHERS AND STUDENTS

The following resources may assist you and your students as they work on their inventions.

Miscellaneous

Internet (try posting questions on local bulletin boards)
Javier Rabelo, teacher (jrabelo@falcon.nvnet.k12.nj.us.) May be able to answer questions.
Nick Frankovits, teacher. May be able to answer questions (pafinc @aol.com)
Popular Science, Popular Mechanics, Discover, and other science and technology-oriented magazines.

Books

Graf, Rudolf F. Encyclopedia of Electronic Circuits.
Blue Ridge Summit, PA: Tab Books, 1985.

Horn, Delton. 101 Solderless Breadboard Projects.
Blue Ridge Summit, PA: Tab Books, 1988.

Macauley, David. The Way Things Work.
Boston: Houghton Mifflin, 1988.

Maloney, Timothy Electricity Fundamental Concepts and Applications.
Albany, N.Y.: Delmar Publishers, 1992.

Markus, John. Popular Circuits Ready Reference.
New York: McGraw Hill, 1982.

Meade, Russell. Foundations of Electronics.
Albany, N.Y.: Delmar Publishers, 1991.

Mims, Forrest M. III. Getting Started in Electronics. Radio Shack, 1983.
(Or any other of Dr. Mims found at Radio Shack retail stores).

Penfold, R. Electronic Projects in the Workshop.
London: Newnes Technical Books, 1979.

The Smithsonian Visual Time line of Inventions.
New York: Dorling Kindersley, 1994.

Catalogs:

Kelvin Electronics (1-800-KELVIN-9)
Mouser Electronics (1-800-346-6873)
Edmund Scientific (1-609-573-6270)
Chaney Electronics (1-800-227-7312)
Sharper Image
Danmark
Brookstone

SCAVENGER PARTS LIST AND SAMPLE ACTVITIES

The following is Northern Valley Regional High School District's Technology Scavenger checklist as well as a list with 25 electrical project ideas to be used with the Scavenger list. With the Scavenger parts, any student could build a mechanical/electrical solution for over 25 projects at very low cost. Virtually all of the parts can be found in any home. If a teacher can supply some test leads, a motor, a relay, a buzzer, a bulb and a socket, the student can supply the rest. This approach has proven very successful in motivating students to look to common sources for materials as they work on inventions. Students learn more by constructing a certain type of switch rather than by purchasing one. Remember, creativity is fostered little by little.

Have your students collect as many of the following items from home as possible. Challenge them to find these items without spending any money. In addition, you should have on hand the following:

Teacher List

1. 1 package of test leads
2. 1 small motor
3. 1 small buzzer
4. 1 piece of foam rubber
5. 1 piece of enamel wire
6. 1 3"x5" piece of pegboard
7. 3 pieces of tin
8. 2 bulbs and sockets
9. 1 batterysnap
10. 1 relay

Student List

1.	1	standard shoe box
2.	5	paper clips
3.	5	rubberbands
4.	1	foot cotton thread
5.	1	foot nylon or fishing line
6.	1	rectangular pencil eraser
7.	10	wooden toothpicks
8.	10	straight shirt pins
9.	2	springs from a pen
10.	1	plastic knife, fork and spoon
11.	5	popsicle sticks
12.	5	wood clothes pins
13.	4	plastic straws
14.	3	plastic screw type soda bottle caps
15.	5	wire garbage bag ties
16.	5	plastic garbage bag ties
17.	3	long and short balloons
18.	5	marbles
19.	1	large spray or detergent plastic cap
20.	2	plasticcups
21.	1	12"X12" piece of aluminum foil
22.	5	copper pennies
23.	4	bobby pins
24.	1	ping pong ball
25.	1	plastic soda or milk bottle
26.	2	large and small zip-lock bags
27.	5	color pencils
28.	1	pint size plastic container with cover
29.	1	12"x12" piece of plastic wrap
30.	1	small magnet
31.	1	black pen and pencil with eraser
32.	1	pair of safety scissors
33.	1	notebook
34.	1	9 volt battery
35.	1	roll of masking tape and 1 roll of electrical tape
36.	1	tube of Elmer's glue
37.	1	tube of crazy glue
38.	2	small pieces of wood (4"x6")
39.	1	sponge type roller

SWITCHES/PROJECTS IDEAS USING "SCAVENGER" PARTS

	TITLE	REAL APPLICATION	SIMULATION
1.	PBNO	survival device	flash light
2.	PBNC	convenience device	open ice box
3.	PB on/off	appliance control	turn on stereo
4.	SPST	slide pressure switch	computer dip switch
5.	DP3T	multi device selector	radio/tape/cd
6.	SPSTknife	pivotal switch	charging device
7.	DPDT knife	multi dir. switch	motorforward/reverse
8.	SPDT knife	industrial control	bulbto motor
9.	SP3T rotary	traffic control	red/yellow/green light
10.	2P3T rotary	channel control device	buzzer/lighVboth
11.	Micro lever switch	counting device	rotate nonconcentric
12.	Water float lever	liquid level sensing	sump pump
13.	Water float ball	limit control device	pool overflow alarm
14.	Tilt motion protector	motion sensing device	auto tire
15.	Magnetic reed	home security device	burglar detector
16.	Membrane	data input device	keyboard
17.	Pneumatic	air pressure device	pressure danger
18.	Puff and sip buzzer	handicapped aid	air in bulb/out
19.	Heat sensor	fire monitoring device	fire alarm
20.	Draft	energy conservation	draftsensor
21.	Electro magnet	magnetic operation	electric swing
22.	Relay no	magnetic control	pb on/motoron
23.	Relay nc	emergency power	power generator
24.	Relay flip flop	advertising device	"eat at joe's" sign
25.	Black box	problem solution device	invention

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